Office of
Fuels
Development

Biomass Ethanol Analytical Task

Quarterly Review

November 1997

Feedstocks

- Cost estimation compatible with U.S. Department of Agriculture's method
- Supply curves fully based on market economics
- Updated in early 1997

Ethanol Production Plants

- Continuous improvement through 2020
- 50 million gallons per year
- Costs based on 1994 NREL work
- Enzymatic hydrolysis technology, with acid hydrolysis technology to be added

Economics of Feedstocks - Waste Feedstocks

- Wastes have low costs in small volumes (less than $20/dry ton), and higher costs as demand increases:
  - Agriculture Residues: $30 to $42/dry ton
  - Waste Hardwood: $30 to $60/dry ton
  - Waste Softwood: $35 to $70/dry ton

Economics of Feedstocks - Biomass Crops

- Biomass crops have lower costs than wastes in high demand situations:
  - Willow: $34 to $42/dry ton
  - Poplar: $40 to $45/dry ton
  - Switchgrass: $28 to $33/dry ton

Analytical Considerations

- Low blends: no change needed in vehicles and infrastructure
- E85: need changes to vehicles and infrastructure
- E85 may need aggressive incentive policy (FY98 to do)

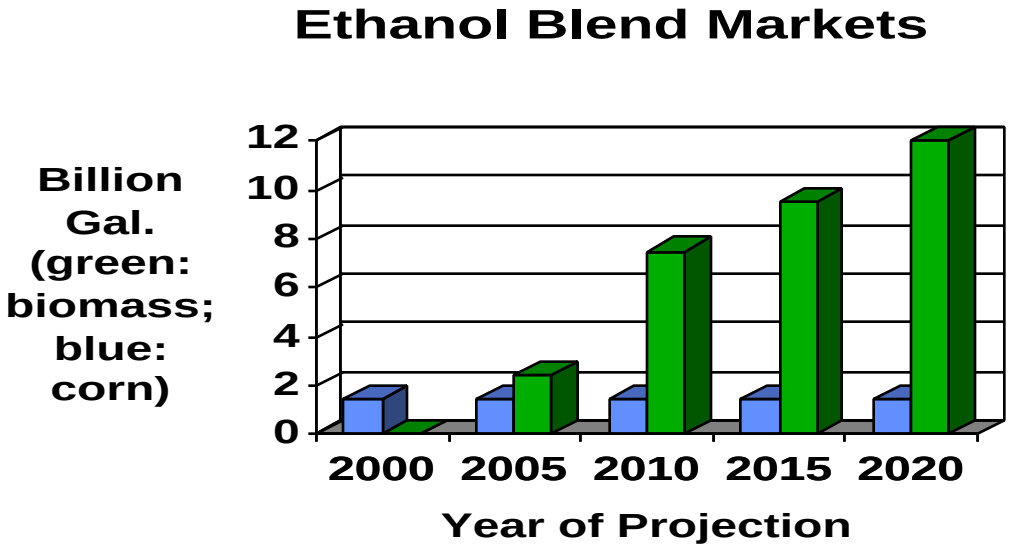
Ethanol Value in Different Markets

- Refiner/blender:
  - Value as MTBE replacement
  - Value as replacement for petroleum components for high octane
- At pump: price of E85 (adjusted for energy content)

Recent Modeling Results

- Tax incentive helps initial phase of cellulosic ethanol industry
- Current incentive is sufficient for cellulosic ethanol (inferred from declining schedules studied to date)
- Corn ethanol will continue to be produced at current level

Ethanol Market Growth (Blends) - Ref. (Declining) Incentive Scenario



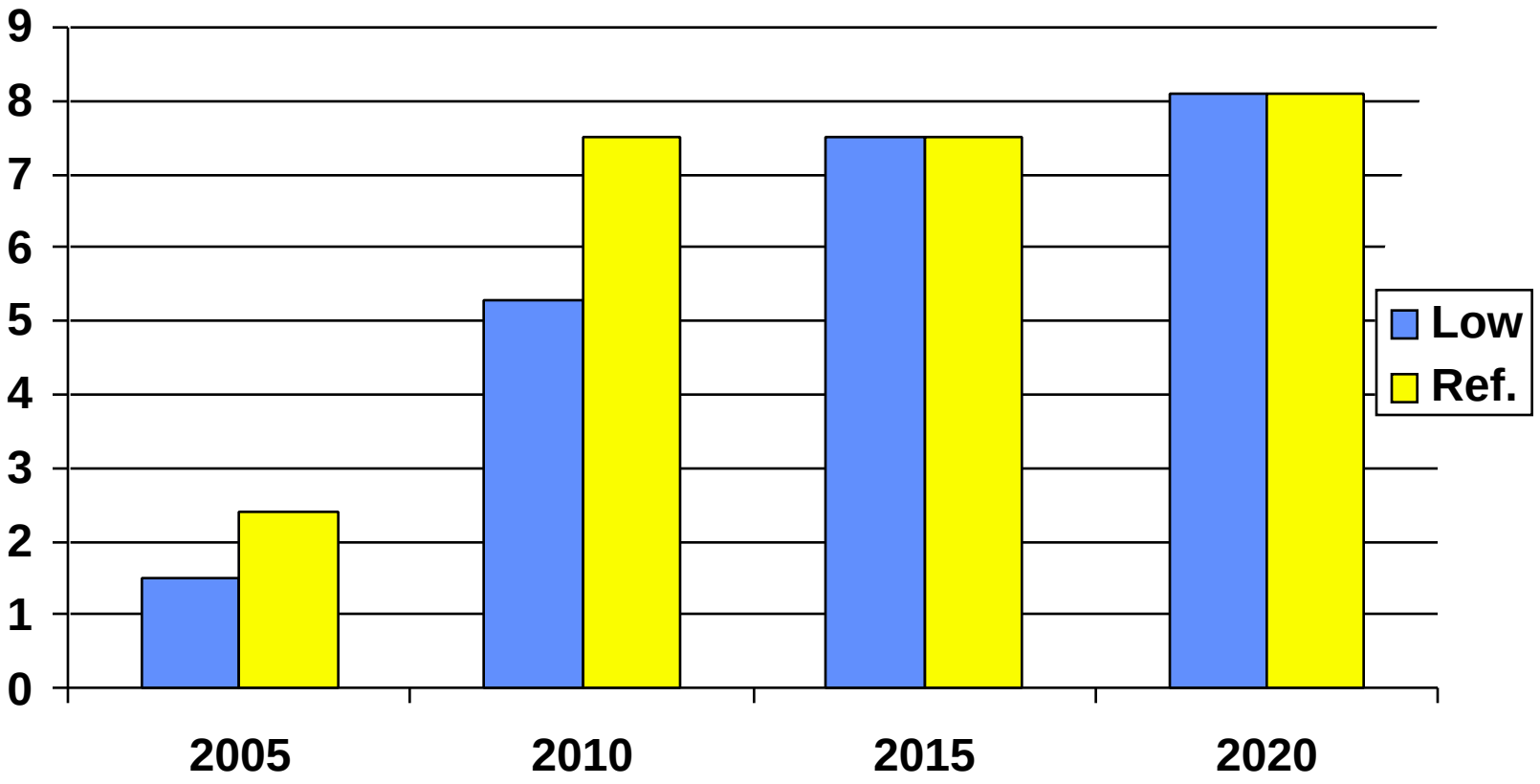
Additional Costs and Benefits

- Oil supply disruptions: 0 to $32 per barrel
- Oil pricing behavior: 0.2 to 0.3% increase in price for each 1% increase in US imports
- CO2 costs: $15 to $330 per ton C
- NOx costs: $2 to $28,500 per ton

Illustrative Results

- Lower incentive scenario: start at 40 c/gal; 5.3 BGY by 2010 (2.5% gasoline displ.) and 8.1 BGY by 2020; cum. C reduction of 219 MM MT by 2025 at $37 per MT
- Ref. incentive scenario: start at 50 c/gal; 7.5 BGY by 2010 (3.5% gasoline displ.) and 8.1 BGY by 2020; cum. C reduction of 236 MM MT by 2025 at $76 per MT

Gallons/Yr For Two Incentive Scenarios



Production Costs

- Marginal Costs
  - Costs of last gallon produced in a given year (most expensive)
  - $1.25 in 2001; $0.98 in 2010; $0.79 in 2020
- Target costs
  - Costs of latest technology for low cost feedstocks
  - $1.16 in 2001; $0.67 in 2010; $0.60 in 2020

Priority Items for FY98 and FY99

- Update of ethanol fuel cycle analysis
- Architect engineering firm
- E85 market analysis with TAFV Model
- 54 c/gal incentive through 2007
- Complete cost benefit analysis
- Distribution costs effects
- Potential low sulfur gasoline